United States Patent [19]

Bancalari

[11] **4,417,223**

[45] **Nov. 22, 1983**

[54] **MULTIPOLE ELECTRIC CIRCUIT BREAKER WITH IMPROVED CURRENT LIMITING DEVICE**

[75] Inventor: **Jean Bancalari,** Grenoble, France

[73] Assignee: **Merlin Gerin,** Grenoble, France

[21] Appl. No.: **346,139**

[22] Filed: **Feb. 5, 1982**

[30] **Foreign Application Priority Data**

Feb. 11, 1981 [FR] France 81 02800

[51] **Int. Cl.**[3] **H01H 77/10**

[52] **U.S. Cl.** **335/195;** 335/16

[58] **Field of Search** 335/16, 195

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,614,687 10/1971 Iida 335/195

FOREIGN PATENT DOCUMENTS

177827 of 0000 Austria .
1665817 of 0000 Fed. Rep. of Germany .
2351483 of 0000 France .

Primary Examiner—Harold Broome
Attorney, Agent, or Firm—Parkhurst & Oliff

[57] **ABSTRACT**

Current limiting circuit breaker having a plurality of movable parallel contact arms vigorously moved in the open circuit position by electrodynamic repulsive forces at the appearance of a short-circuit current. The opening movement of one of said contact arms is limited by an abutment and the movement of the other contact arms is limited by a lost motion mechanical linkage connecting together said contact arms so as to delay the reclosure and to prevent a reclosing before tripping of the circuit breaker.

4 Claims, 2 Drawing Figures

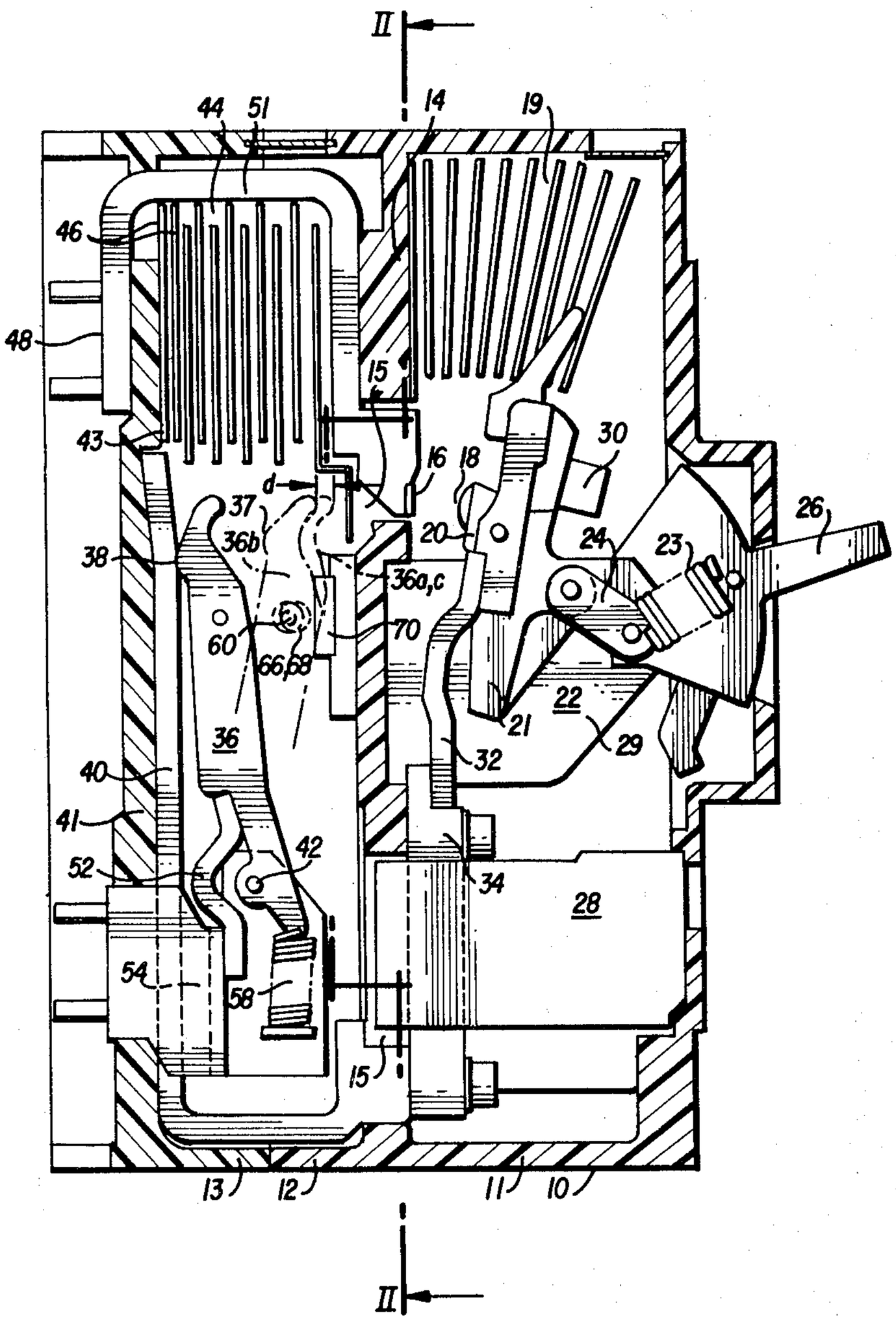
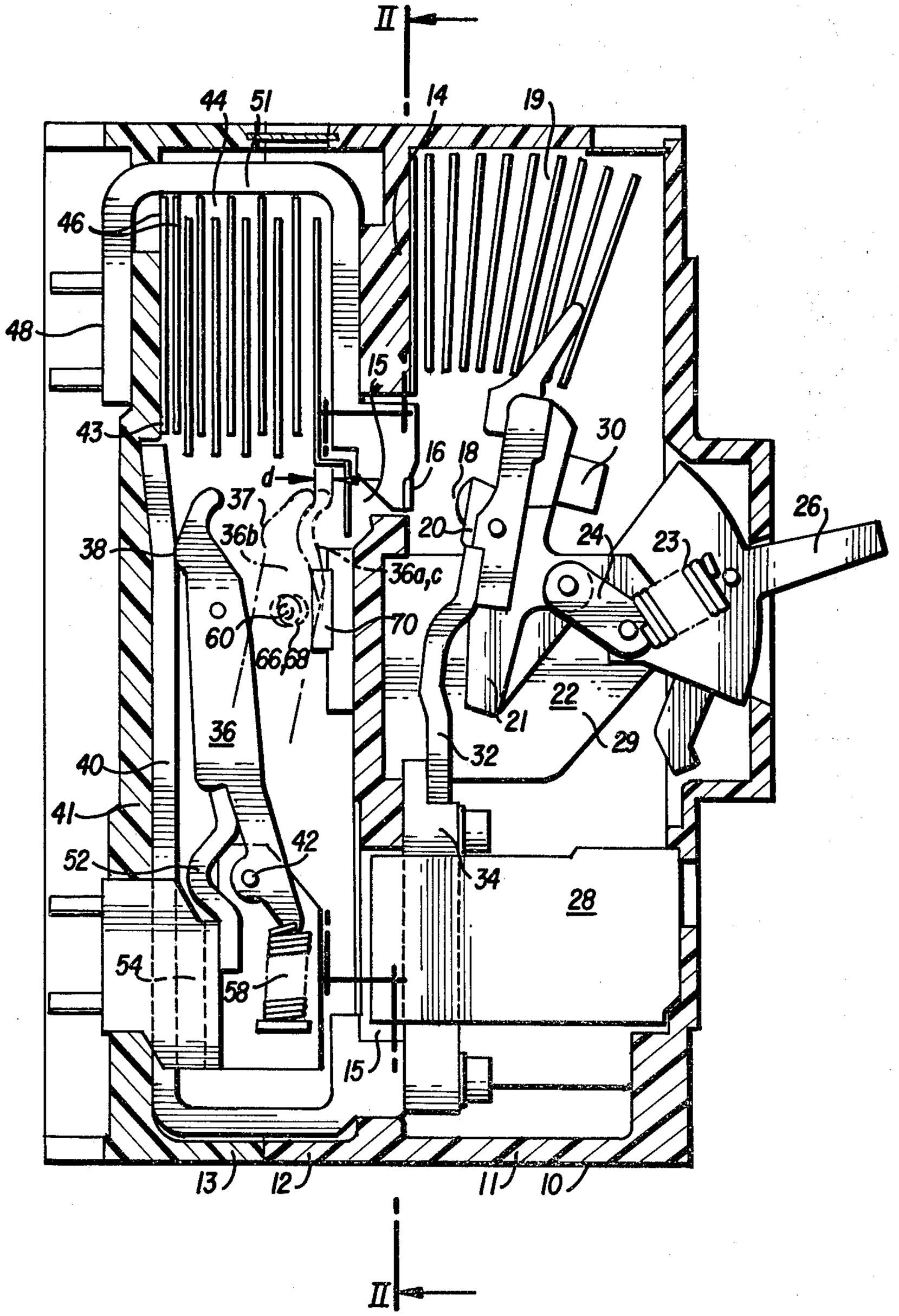


FIG. 1


II
44
51
14
19
46
48
15
43
30
16
18
d
37
36b
20
24
23
26
38
36a,c
60
70
66,68
22
21
36
32
29
40
41
42
34
52
28
54
58
15
13
12
11
10
II

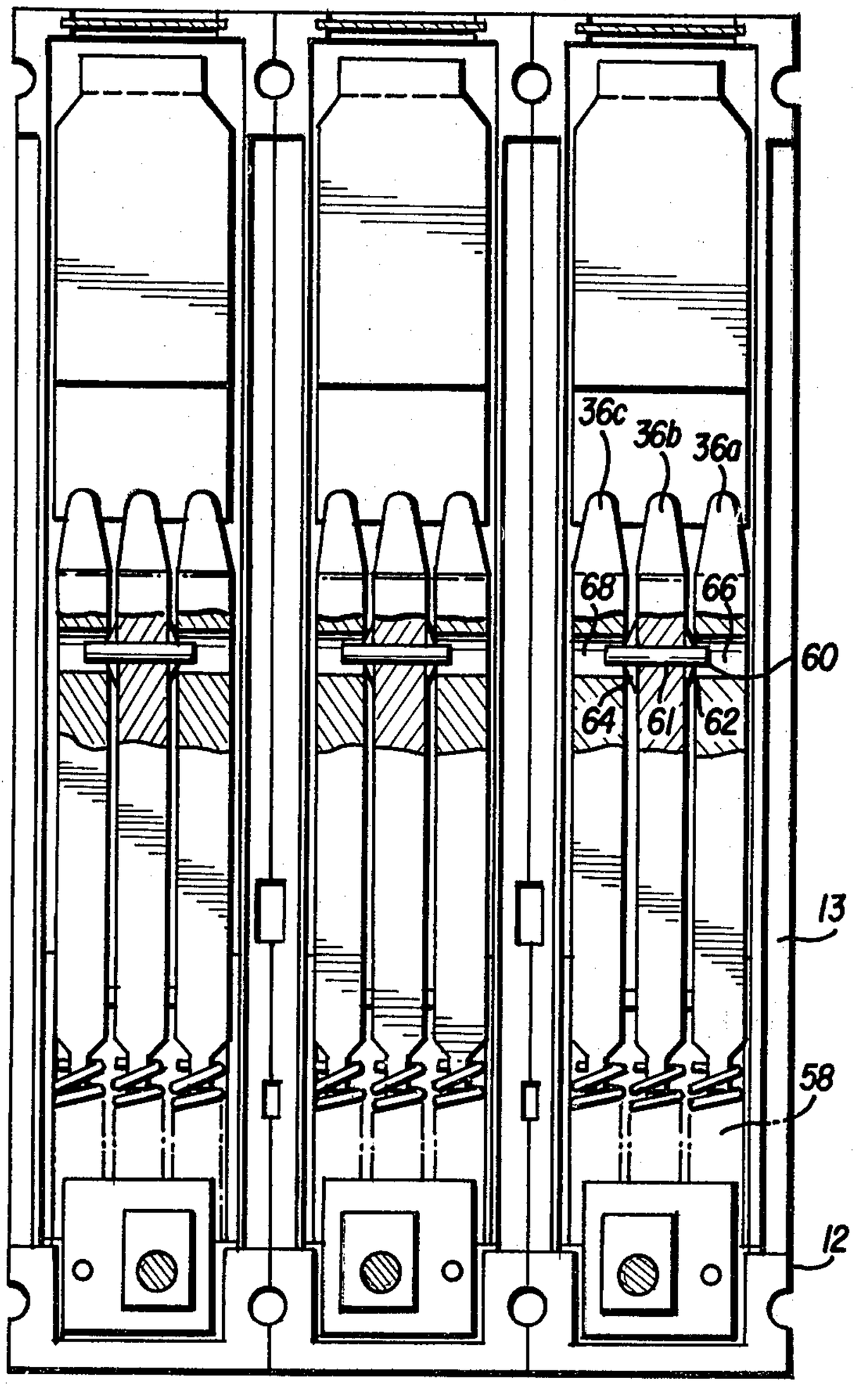


FIG. 2

MULTIPOLE ELECTRIC CIRCUIT BREAKER WITH IMPROVED CURRENT LIMITING DEVICE

This invention relates to a low voltage, multipole current limiting circuit breaker having a number of movable parallel contact arms, each arm subject to high-speed opening through electrodynamic auto-repulsive forces under the effect of a sudden increase in current, and a braking component cooperating at the end of the opening travel with the aforementioned contact arms so that the opening time during the auto-repulsion phase will be greater than the response time of the tripping unit.

A current limiting device of the type mentioned is described in U.S. Pat. No. 4,118,681, in which each pole has its own inertia block of predetermined weight, linked mechanically to the mobile contact by an idle-travel mechanical link, and able to execute a limited movement in relation to said mobile contact. There is one biasing spring associated with the mechanical link, and a second pressure contact spring bearing on the mobile contact in the closed position. The high speed movement of the mobile contact into the open position is achieved by means of an auxiliary magnetic circuit with a narrow gap surrounding at least one current carrying conductor. The use of such a braking component with a current limiting circuit breaker for high ratings, for instance 1000 A, comprising a large number of mobile contacts with high speed opening through electrodynamic autorepulsive forces for each pole, entails problems in functioning and problems of space inside the insulating box of the circuit breaker.

The object of the present invention is to achieve a high rating current limiting circuit breaker equipped with a simple and reliable, inertia-type braking component.

According to the invention, the braking component has an inertia block formed by one contact arm, connected by a lost motion travel mechanical linkage to a second adjacent contact arm cooperating in the open position with a stop, arranged so that it prevents the movement of the second arm beyond the open position and so that it allows the continued movement of the first adjacent arm until it reaches the end of the idle travel of the mechanical linkage, the inertia of the first arm then compensating the impact when the second arm and the stop come into contact, in order to prevent immediate reclosure of the contact arms before the tripping unit operates.

The inertia of at least one mobile contact arm is used to constitute the inertia block of the braking component.

According to one embodiment of the invention, the said mechanical linkage comprises a drive component fixed to the second contact arm associated with the stop and cooperating with clearance with the first adjacent inertia block arm capable of restricted movement during the said idle travel.

According to another embodiment of the invention, the drive component of the mechanical linkage comprises a lock-pin attached to the second contact arm and lying in a transverse direction through an opening provided in the first adjacent contact arm, the diameter of the opening being larger than that of the pin to provide the aforementioned idle travel. The lock-pin is advantageously attached to an intermediate second contact arm, inserted between the first and a third contact arm

of identical design. Other advantages and features will be more clearly apparent from the following description of a mode of construction furnished as a non-exhaustive example, and illustrated in the attached drawings in which:

FIG. **1** is a view of a vertical section through a limiting circuit breaker equipped with a braking component according to the invention;

FIG. **2** is a view of a section along line II—II of FIG. **1**.

On FIGS. **1** and **2**, a low voltage, multipole limiting circuit breaker for high current ratings, such as of the order 1,000 Amperes, is made up of a standard circuit breaker unit **10** in a moulded insulating box **11** placed on top of a lower limiting unit **12** in a moulded insulating box **13** having the same dimensions of base plate. When boxes **11**, **13** are assembled, for instance by fixing screws, the intermediate open back panel **14** forms a separating panel between the two units **11**, **13** and has holes **15** through which the connecting conductors can be run.

Circuit breaker unit **10**, of familiar design, has on each pole fixed contacts **16** arranged near back panel **14** and cooperating in the closed position with corresponding mobile contacts **18** carried by a number of pivoting fingers **20** housed in a cage **21**. A breaking chamber **19** is provided in each pole and comprises a stack of metal separators to extinguish the arc drawn between contacts **16**, **18** when they separate. An operating mechanism **22** with toggle mechanism **24** and energy storage spring **23** is fitted in the central part of box **11** and controls closing and opening of contact fingers **20**, either by manual action of an external handle **26** or by interaction of a tripping unit **28** that causes automatic release of tripping lever **29** associated with mechanism **22** and entails opening of the circuit breaker in the case of a fault. Tripping unit **28** has an adjustable tripping threshold of the magneto-thermal or electronic type and is sensitive to overload or short-circuit circuits. It is placed lengthwise on the opposite side of mechanism **22** to breaking chamber **19**. A cross bar **30** common to all the poles, lies in the transverse direction of the box and cooperates with operating mechanism **22** for the simultaneous actuation of the various adjacent cages **21** when manual or automatic control is effective. A connecting flex **32** forms the electrical connection between the rear of each contact finger **20** and a conducting strip **34** crossing tripping unit **28**. A circuit breaker unit such as **10** is well known in the art and a detailed description of its design and operation will not be given here. Limiting unit **12** mounted against intermediate back panel **14** has three adjacent contact arms **36***a*, **36***b*, **36***c* per pole, each arm **36** having an elongated shape lying in the longitudinal direction of box **13** and parallel to contact fingers **20** of upper circuit breaker unit **10**. One of the ends of each arm **36***a*, **36***b*, **36***c*, carries a mobile contact **37** cooperating in the closed position with a fixed contact **38** mounted on a fixed conductor **40** lying flat on the back panel **41** of box **13**. The opposite end of arm **36***a*, **36***b*, **36***c*, is articulated on a swivel pin **42** oriented in the transverse direction of bar **30** and housed in box **13** between conductor **40** and the lower part of tripping unit **28**. Conductor **40** extends beyond fixed contact **38** in the direction of an end plate **43** which is part of an arc extinguishing chamber **44** having deionizing plates **46** arranged under the breaking chamber **19** of circuit breaker unit **10**. The opposite end of extended conductor **40** goes through hole **15** in back panel **14** and is fixed

to strip **34** crossing tripping unit **28**. When contacts **37**, **38** of limiting unit **12** are in the closed position, each contact arm **36***a*, **36***b*, **36***c*, lies parallel and close to conductor **40** to form a large current loop subjected to electrodynamic repulsive forces when a short-circuit current occurs. A compression spring **58** placed opposite chamber **44** acts on each arm **36***a*, **36***b*, **36***c* to close contacts **37**, **38**. The line of action of spring **58** is practically perpendicular to the transverse direction of swivel pin (**42**) and the return force of spring **58** is applied to the end of arm **36** opposite mobile contact **37**.

Connecting flex **52** forms the electrical connection between each mobile contact arm **36***a*, **36***b*, **36***c* and a first connecting terminal **50** by means of a perpendicular conductor **54** running through a hole provided in back panel **41**. Lower conductor **40** runs through conductor **54** lengthwise. The second connection terminal **48** is fixed to a C-shaped linking conductor **51** running behind deionizing plates **46** of arc extinguishing chamber **44** in order to attract the arc drawn between contacts **37**, **38**. Linking conductor **51** goes through hole **15** in intermediate back panel **14** and connects to fixed contact **16** of the corresponding pole of circuit breaker **10**. Note that the two connecting terminals **48**, **50**, of each pole of the limiting circuit breaker are mounted under the base back panel of limiting unit **12**, so as to avoid current leadins through the side panels of boxes **11**.

Each pole of limiting unit **12** is equipped with an inertiatype braking device which comes into action at the end of opening travel of contact arms **36***a*, **36***b*, **36***c*, to brake their fall into closed position by obstructing reclosure of contacts **37**, **38** until circuit breaker unit **10** trips. Central contact arm **36***b*, is provided for this purpose with a lock-pin **60** held in a circular hole **61** by two lock-washers **62**, **64**, bearing on opposite faces of said arm **36***b*. Lock-pin **60** lies parallel to swivel pin **42** in the transverse direction of box **13** and its two opposite ends adjust into circular openings **66**, **68**, provided respectively in the two other adjacent side arms **36***a*, **36***c*, lying on either side of central contact arm **36***b*. Each opening **66**, **68** has a diameter greater than that of lock-pin **60**. The length of this pin is also shorter than the length of a pole. A raised part **70** projecting from the intermediate back panel **14** acts as a shock-absorber for the central contact arm **36***b* when it reaches the end of its opening travel.

The operation of each pole of the current limiting circuit breaker according to the invention is as follows:

With the limiting circuit breaker in the closed position, the current in each pole, enters, for instance, through connection terminal **48**, goes through linking conductor **51** of limiting unit **12**, closed contacts **16**, **18** of circuit breaker unit **10**, contact fingers **20**, connecting flex **32** of connection strip **34**, then conductor **40**, closed contacts **38**, **37** and contact arms **36***a*, **36***b*, **36***c*, of limiting unit **12**, flexes **52**, conductor **54** through back panel **41**, and goes out through connection terminal **50**. Operating mechanism **22** of the circuit breaker unit is now locked with actuating spring **23** in charged position.

In the event of overload or slight short circuit currents, limiting unit **12** is not operative and contacts **37**, **38** remain closed due to the predominating action of contact pressure springs **58** compared with the weak electrodynamic repulsive forces acting between contact arms **36** and conductor **40**. The fault is detected by tripping unit **28** which controls release of tripping lever **29** in mechanism **22**, followed by opening of contacts **16**, **18** of circuit breaker unit **10**, and extinction of the arc in breaking chamber **19**.

When a significant short-circuit current occurs, the electrodynamic tripping threshold of limiting unit **12** is overstepped and the electrodynamic repulsive forces acting on the swivel contact arms **36** override the action of springs **58**. As a result, contacts **37**, **38** open rapidly, limiting the current before operating mechanism **22** of circuit breaker unit **10** is called into action. Reclosing of contacts **37**, **38** of limiting unit **12** during the short-circuit before final opening of contacts **16**, **18** of circuit breaker unit **10**, is prevented by the reaction of the inertia-type braking device that is actuated when the central contact arm **36***b* (dotted-dashed lines in FIG. **1**) thrusts against the raised part **70** of the intermediate back panel **14**. However, this blocking of the swing of central arm **36***b* at the end of the first opening phase, does not prevent the continued movement of side arms **36***a*, **36***c*, during idle travel, d, commenced during the second opening phase. This idle travel d ceases when holes **66**, **68** of side fingers **36***a*, **36***c* (dashed lines FIG. **1**) engage with lock-pin **60** of central arm **36***b*. The impact generated when central arm **36***b* comes up against raised part **70** tends to propulse central arm **36***b* back to the closed position. Due to the loose mechanical linkage of lock-pin **60** in holes **66**, **68**, the fall of central arm **36***b* is braked then reversed due to the inertia of side arms **36***a*, **36***c*, which act as compensating inertia blocks. The arrangement of springs **58** generates a low torque on contact arms **36***a*, **36***b*, **36***c*, at the onset of the return travel to closed position. The duration of opening of contact arms **36***a*, **36***b*, **36***c*, is longer than the response time of tripping unit **28**, so that the fault will be definitely eliminated by circuit breaker unit **10** before limiting unit **12** recloses.

The invention is not restricted to the mode of construction described, but covers equally all alternative construction modes embodying equivalent electrotechnical provisions, in particular that in which a different number of contact arms **36***a*, **36***b*, **36***c* . . . may be adopted for limiting unit **12**, and that in which the loose mechanical linkage for the inertiatype braking device may be achieved through a different design. This braking device has been described with respect to a modular limiting unit **12** in association with an independent circuit breaker unit **10** having an automatic tripping mechanism **28**, but the braking device according to the invention naturally applies to any other limiting circuit breaker combining current limiting and current breaking functions in one and the same apparatus.

What is claimed is:

1. A multipole current limiting circuit breaker with an automatic tripping unit, each pole comprising:

a plurality of movable parallel contact arms,

electrodynamic auto-repulsive means for imparting a substantially equal opening force to each of said contact arms under the effect of a sudden increase in current whereby each of the contact arms are repulsed simultaneously,

spring means to urge said arms in the closed position,

a lost motion mechanical linkage connecting a first of said contact arms with a second of said contact arms,

abutment means cooperating only with the second contact arm for preventing the movement of the second contact arm beyond a predetermined position, said first contact arm being free to continue the opening movement beyond said abutment

means by said lost motion linkage so that the inertia of the first contact arm compensates for the impact of the second arm on the abutment means and prevents immediate reclosure of the contact arms until such time as the tripping device is actuated.

2. A circuit breaker according to claim 1, said mechanical linkage comprising a lock-pin attached to said second arm so as to protrude laterally, said first arm having an opening through which extends with clearance said lock-pin to provide the lost motion mechanical linkage.

3. A circuit breaker according to claim 2, having three parallel contact arms, said lock-pin being secured to the intermediate contact arm to protrude on both sides for cooperation with the two other contact arms.

4. A circuit breaker according to claim 1, further comprising overload contacts electrically connected in series with said contact arms, said automatic tripping device provoking the opening of said overload contacts upon the occurrence of a predetermined overload, the reclosure of the contact arms being delayed until after the opening of said overload contacts.

* * * * *